What is claimed is:

1. A method of reducing a compound to form a reduction product, said method comprising the step of combining the compound with a lanthanide catalyst having the formula:

$$G_1\text{-}M\text{-}G_2$$

wherein;

M is a lanthanide other than the Europium, Ytterbium or Samarium;

G_1 and G_2 are chemical entities independently selected from the group consisting of a halogen, an alkyl, an aryl, an NR_2, an OR_2, a PR_2 and an SR; wherein N is a nitrogen, O is an oxygen, P is a phosphorus and R is selected from the group consisting of an alkyl, an aryl, and a cycloalkyl from about 1 to about 20 carbon atoms.

2. A method according to claim 1 wherein M is selected from the group consisting of Thulium, Dysprosium, Neodymium, Cerium, Praseodymium, Gadolinium, Terbium, Holmium, Erbium, Lutetium, Lanthanum and Yttrium.

3. A method according to claim 1 wherein the M is a Thulium.

4. A method according to claim 1 wherein the M is a Dysprosium.

5. A method according to claim 1 wherein the M is a Neodymium.

6. A method according to claim 1 wherein G_1 is an Iodine.

7. A method according to claim 1 wherein G_2 is an Iodine.

8. A method according to claim 1 wherein G_1 and G_2 are the same halogen.

9. A method according to claim 1 wherein G_1 and G_2 are different halogens.

10. A method according to claim 1 wherein M is a Thulium and G_1 and G_2 are iodines.

11. A method according to claim 1 wherein M is a Dysprosium and G_1 and G_2 are iodines.

12. A method according to claim 1 wherein M is complexed with at least one solvent molecule, S.

13. A method according to claim 12 wherein the solvent molecule comprises a Lewis base.

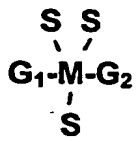
14. A method according to claim 13 wherein the Lewis base is a heteroatom donor base.

15. A method according to claim 13 wherein the Lewis base is selected from the group consisting of di-alkyl-oxy-ethanes, tetrahydrofuran, dienes, nitriles and ethers.

16. A method according to claim 13 wherein the Lewis base comprises a di-alkyl-oxy-ethane.

17. A method according to claim 13 wherein the Lewis base comprises a dimethoxyethane.

18. A method according to Claim 12 wherein the complex has the general Formula B:



wherein;

M is a lanthanide other than the Europium, Ytterbium or Samarium;

G_1 and G_2 are chemical entities independently selected from the group consisting of a halogen, an alkyl, an aryl, an NR_2, an OR_2, a PR_2 and an SR; wherein N is a nitrogen, O is an oxygen, P is a phosphorus and R is selected from the group consisting of an alkyl, an aryl, and a cycloalkyl from about 1 to about 20 carbon atoms; and,

S is dimethoxyethane (DME).

19. A method according to claim 18 wherein M is Thulium, G_1 and G_2 are Iodine and S is dimethoxyethane.

20. A method according to Claim 18 wherein M is Dysprosium, G_1 and G_2 are Iodine, and S is dimethoxyethane.

21. A method according to claim 1 wherein the compound is an organic compound, the lanthanide catalyst effects alkylation of the compound, and the reduction product is an alkylated organic compound.

22. A method according to claim 21 wherein the lanthanide catalyst is a Thulium diiodide.

23. A method according to claim 21 wherein the lanthanide catalyst effects alkylation of the organic compound with RJ, wherein R is an alkyl and J is a halogen selected from the group consisting of Iodine, Bromine, Chlorine and Fluorine.

24. A method according to claim 23 wherein G_1 and G_2 are Bromine.

25. A method according to claim 23 wherein G_1 and G_2 are Chlorine.

26. A method according to claim 1 wherein the compound comprises a polymerizable unit and the reduced product is a polymer.

27. A method according to claim 26 wherein the M is a Dysprosium, G_1 and G_2 are Iodine.

28. A method according to claim 26 wherein the polymerizable unit comprises isoprene.

29. A reduction product made from a process comprising the step of combining a compound with a lanthanide catalyst having the general Formula A:

$$G_1\text{-}M\text{-}G_2$$

wherein;

L is a lanthanide other than the Europium, Ytterbium or Samarium;

G_1 and G_2 are chemical entities independently selected from the group consisting of a halogen, an alkyl, an aryl, an NR_2, an OR_2, a PR_2 and an SR; wherein N is a nitrogen, O is an oxygen, P is a phosphorus and R is selected from the group consisting of an alkyl, an aryl, and a cycloalkyl from about 1 to about 20 carbon atoms.

30. A reduction product according to claim 29 wherein the compound comprises a polymerizable unit and the reduced product is a polymer.

31. A reduction product according to claim 29 wherein the M is a

Dysprosium, G_1 and G_2 are Iodine.

32. A reduction product according to claim 29 wherein the polymerizable unit comprises isoprene.

33. A method for making a dihalogenated lanthanide compound, wherein the lanthanide is other than Europium, Ytterbium or Samarium, said method comprising the steps of:

combining a lanthanide metal with a halogen;

reacting the lanthanide with the halogen to form an initial mixture; and

heating the initial mixture for about 1 to about 60 minutes.

34. A method according to claim 33 wherein the lanthanide metal is selected from the group consisting of Thulium, Dysprosium, Neodymium, Cerium, Praseodymium, Gadolinium, Terbium, Holmium, Erbium, Lutetium, Lanthanum and Yttrium.

35. A method according to claim 33 wherein the lanthanide metal is Dysprosium metal.

36. A method according to claim 33 wherein the halogen is selected from the group consisting of Iodine, Bromine, Chlorine and Fluorine.

37. A method according to claim 33 wherein the halogen is Iodine.

38. A method according to claim 33 wherein the heating is for about 2 to about 30 minutes.

39. A method for making a dihalogenated lanthanide complex, wherein the lanthanide is other than Europium, Ytterbium or Samarium, said method comprising the steps of:

combining a lanthanide metal with a halogen and a solvent molecule S;

refluxing the mixture of the lanthanide, the halogen and the solvent molecule S under inert gas for about 15 minutes to about 90 minutes without substantial use of repeated vacuum transfers.

40. A method according to claim 39 wherein the lanthanide metal is selected from the group consisting of Thulium, Neodymium, Cerium, Praseodymium, Gadolinium, Terbium, Holmium, Erbium, Lutetium, Lanthanum and Yttrium.

41. A method according to claim 39 wherein the lanthanide metal is Thulium metal.

42. A method according to claim 39 wherein the halogen is selected from the group consisting of Iodine, Bromine, Chlorine and Fluorine.

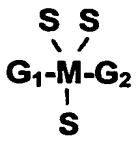
43. A method according to claim 39 wherein the halogen is Iodine.

44. A method according to claim 39 wherein the solvent molecule S comprises a Lewis base.

45. A method according to claim 39 wherein the Lewis base is selected from the group consisting of di-alkyl-oxy-ethanes, tetrahydrofuran, dienes, nitriles and ethers.

46. A method according to claim 39 wherein the Lewis base comprises a dimethoxyethane.

47. A method according to claim 39 wherein the dihalogenated lanthanide complex comprises the general Formula B:



wherein;

M is a Thulium;

G_1 is an Iodine;

G_2 is an Iodine; and

S is dimethoxyethane (DME).